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November 5, 2018

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Case Number: 10-0081-34-19
Report Number: TS333150-X29003K6D

Executive Summary

Device Analyzed: Trilogy Logs from TASER® X2™ Conducted Energy Weapon (CEW) with serial number X29003K6D (the X2 CEW).

Primary Findings:

- The X2 CEW is recording data properly in the Trilogy Logs.
- The X2 CEW was activated one (1) time via the trigger switch and three (3) times via the arc switch on September 11, 2018 between 16:13 and 16:14 EDT, not including clock drift.
- The X26 CEW had 22 minutes and 19 seconds of positive (fast) clock drift on September 11, 2018.
- The X2 CEW's pulse graphs indicate the X2 CEW has no connection with the subject for the trigger and first arc activations.
- The X2 CEW's pulse graphs indicate the second and third arc activations appear consistent with a drive stun application over skin and possibly clothing.

Report from Axon Enterprise, Inc.
Download Analysis of TASER X2 X29003K6D, TS #333150

Report:

Axon Enterprise, Inc. (Axon) was asked to conduct a download analysis of the X2 CEW with serial number X29003K6D, manufactured on April 7, 2015, in reference to a reported usage on September 11, 2018 at approximately 15:30 Eastern Daylight Time (EDT). The X2 CEW was received by Axon along with 2 other X2 CEWs with serial numbers X29003HFY and X29003M57, each sealed in a handgun collection and storage box on September 25, 2018 via UPS 2nd Day Air, tracking number 1ZA936123597332156. The download and analysis were performed at Axon's headquarters facility in Scottsdale, Arizona on October 10, 2018.

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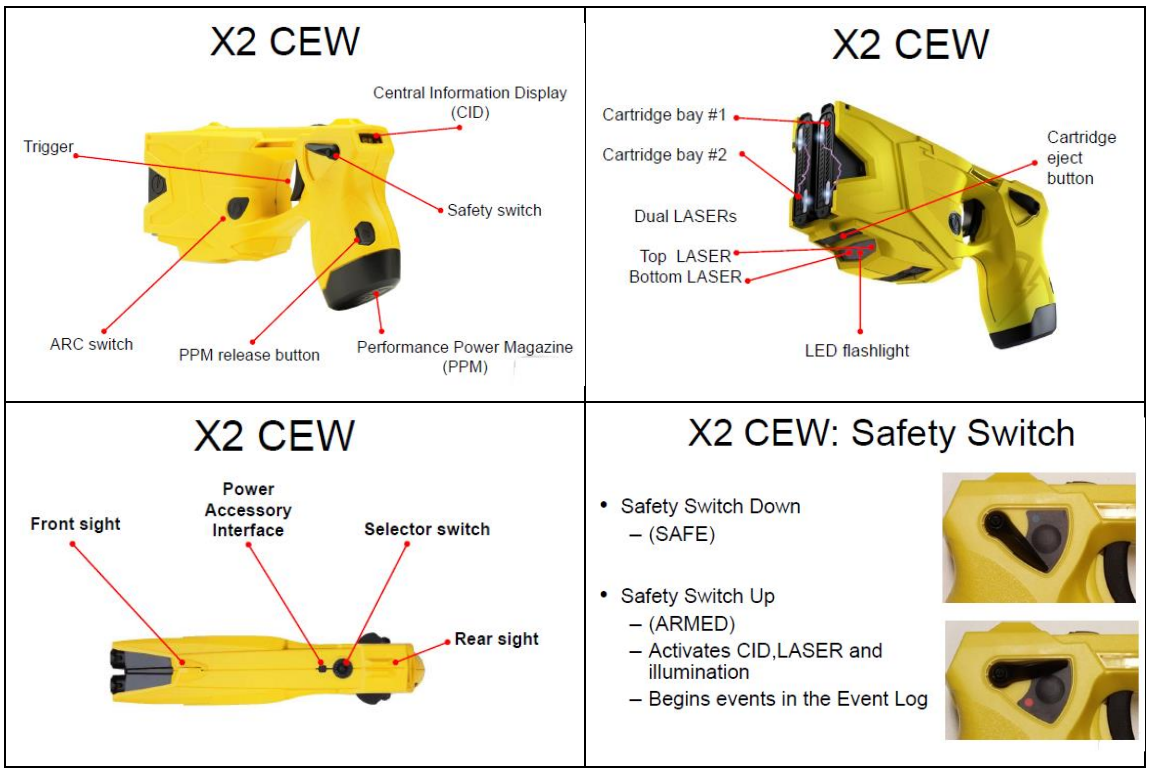
1. X2 CEW Generally

The TASER X2 CEW is a dual cartridge CEW in the Axon Smart CEW line that was first available in April 2011, and designed significantly on the TASER X3 CEW platform that was first available in July 2009.



Smart Cartridges: The X2 CEW uses Axon's Smart cartridges and is not compatible with Axon standard cartridges. When Smart cartridges are loaded into the X2 CEW and when the X2 CEW is armed, it will read the cartridge type and display it on the Central Information Display (CID). The cartridge types can be displayed as: live 15', 25'; training 25'; or deployed. The X2 CEW contains 2 cartridge bays. Bay 1 (cartridge 1) is on the left side of the weapon (from the user's aim perspective). Bay 2 (cartridge 2) is on the right side of the weapon (from the user's aim perspective).

Safety Switch: The X2 CEW features an ambidextrous safety switch. When the safety switch is placed in the Armed (up) position, the weapon is ready to activate. The X2 CEW will arm anytime the safety switch is placed in the Armed position, except when in Universal Serial Bus (USB) mode. When the X2 CEW is armed, it will automatically select the first bay that has a loaded and un-deployed cartridge, starting with Bay 1. If no cartridges are present, then Bay 1 will be selected. If 1 bay contains a previously deployed cartridge and the other bay contains an un-deployed cartridge, the X2 CEW

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will select the un-deployed cartridge. The X2 CEW enters safe mode when the safety switch is placed in the Safe (down) position.

Trigger: When the X2 CEW is armed and the trigger is pulled, if there is an un-deployed cartridge it will deploy the cartridge in the selected bay and activate the high voltage pulses on the selected bay for 5 seconds at 19 ± 1 pulses per second (pps). If the selected bay has no cartridge or a deployed cartridge, the trigger will only activate the high voltage pulses on the selected bay and not attempt to activate the cartridge deployment circuitry. The trigger only activates the high voltage on the selected bay. If the trigger is pulled and then released, after 5 seconds the high voltage activation will stop. With a standard battery pack, if the trigger is held beyond 5 seconds, the high voltage will remain active as long as the trigger is held, until the battery is depleted, or when the safety switch is placed in the Safety position, whichever occurs first. If the safety is placed in the Safety position during any active cycle, the CEW will immediately end the discharge and turn off. Axon also offers battery packs and TASER CAM-HD recorders that limit activations to 5 seconds, regardless of the trigger being held, e.g., Auto Shut-Down Performance Power Magazine (APPM) or the Auto Shut-Down TASER CAM-HD. The APPM gives an audible beeping warning tone at the 4th second of the activation until the activation stops or the trigger is released. Another 5-second activation can only be initiated by pulling the trigger again.

ARC Switch: The X2 CEW features an ARC switch that has dual functions: (1) 2 bay arc activation; and (2) cartridge selection. The cartridges do not deploy with the ARC switch, rather, cartridges can only be deployed with a trigger activation. When the ARC switch is held for longer than 0.25 seconds, both cartridge bays will activate the high voltage pulses at 19 ± 1 pps. With a standard battery pack, the high voltage will be active on both cartridge bays as long as the ARC switch is depressed. The high voltage pulses will stop when the ARC switch is released. Axon also offers battery packs and TASER CAM-HD recorders that limit ARC switch activations to 5 seconds, regardless of the ARC switch being held (e.g., APPM and Auto Shut-Down TASER CAM-HD). The APPM gives an audible beeping warning tone at the 4th second of the activation until the activation stops or the ARC switch is released. When the ARC switch is "tapped", or pressed for less than 0.25 seconds, the X2 CEW will advance the cartridge selection to the next cartridge bay, providing it is selectable. When a cartridge is selected, it can be deployed only via the trigger switch.

Weapon Mode and Cartridge Selection: The X2 CEW can operate in two weapon modes: semi-automatic or manual mode. The weapon mode is an agency selectable software setting, set on the agency's Evidence.com account. If the agency does not have an Evidence.com account, the X2 CEW will remain in the factory default, semi-automatic mode. The weapon mode determines how the X2 CEW will advance to the next available cartridge when a cartridge is deployed.

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Semi-automatic Mode: When a cartridge is deployed by a trigger pull, the next cartridge will be selected when the trigger is released. If there is no cartridge available (i.e., empty bay or deployed cartridge installed), then the cartridge selection will not advance to the next bay.

Manual Mode: When a cartridge is deployed by a trigger pull, the cartridge bay selection will remain on the selected bay until the user manually advances to the next available cartridge. The user advances the cartridge selection by tapping the ARC switch. If there is no cartridge available (i.e., empty bay), then the cartridge selection will not advance to the next bay.

Regardless of the weapon mode, the cartridge bay can be selected by tapping the ARC switch. There are, however, conditions when a cartridge bay cannot be selected. Bay 2 cannot be selected when it is empty. A deployed cartridge cannot be selected if there is still an un-deployed cartridge installed in another bay. Once both cartridges are deployed, then deployed cartridges can be selected. A cartridge with a fault detected by the weapon also cannot be selected.

Menu and Selector Button: The X2 CEW menu is used to read or change the targeting aid sighting LASER (Light Amplification by Stimulated Emission of Radiation) and flashlight, illumination settings, and read information, such as the battery pack details, system time, and system firmware version. The menu can be selected by pressing the Selector Button on the top of the weapon while in safe mode. Note that the X2 CEW can be armed and activated at any time, even when the weapon is in the menu settings. When the X2 CEW is armed, the Selector Button will put the weapon in "stealth" mode, which will dim the CID and turn off the LASER and flashlight.

Trilogy Logs: The X2 CEW records information into the Trilogy™ Logs, which consist of (1) the Event Log, (2) the Pulse Logs, and (3) the Engineering Logs.

Event Log: The Event Log is a recording of the date, time, and details of each event that occurs with the X2 CEW, including every time the weapon is armed, the trigger is pulled, the ARC switch is pressed, the menu is accessed, the time is changed, the safety switch is placed in the safe position, USB mode is entered, the firmware is updated, and more. Relevant events also include the cartridge status, internal temperature of the weapon, the duration of the event (in seconds), and the battery percentage remaining at the time of the event. The Event Log will record approximately 16,000 entries before it will "wrap" and begin to overwrite the oldest entries.

Pulse Logs: The Pulse Logs are a recording of every pulse that is generated by the X2 CEW. There are three measurements recorded for each pulse: (1) the voltage across the stimulation capacitor; (2) the voltage across the arc

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capacitor; and (3) the charge delivered from the X2 CEW output. The Pulse Log is an allocated part of memory and records each pulse from each activation, regardless of the duration of the activation. Therefore, the number of activations stored in the Pulse Log is variable and dependent on the duration of the activations. Based on 5-second activations only, the Pulse Log will store 422 activations before the memory fills to capacity. Once the memory is full it will delete the oldest sector of memory to free up space, which will delete the oldest 40 (5-second) activations. However, based on specific usage, the number of activations stored in the Pulse Log could be more or less.

Engineering Logs: The Engineering Logs are a recording of all activity in the X2 CEW. The Engineering Log records, along with a timestamp, every button push, microprocessor command, circuit status, reported errors, faults and more. The Engineering Logs are only accessible by Axon Engineering and are used for troubleshooting purposes or acquiring deeper information about a specific activation or incident.

USB: The X2 CEW is downloaded by connecting the CEW to a proprietary USB pack that inserts into the CEW's battery pack compartment. Once connected to USB, the X2 CEW will enter USB mode and the CEW's Trilogy Logs can be downloaded to a local Personal Computer (PC) or network or uploaded to Evidence.com using Evidence Sync software. USB mode also allows the synchronization of the X2 CEW clock, firmware updates, and configuration setting.

Effectiveness: CEWs are designed to cause neuromuscular incapacitation (NMI) when conditions are met. These required conditions include:

- There is a completed and maintained circuit between the electrodes (or probes) to allow electrical current to flow
- There is sufficient spread, or distance, between the electrodes
- There is sufficient motor-nerve mediated muscle mass between the electrodes

When the X2 CEW is activated and all required conditions are met, the subject will likely experience some degree of NMI, in which some of his/her muscles will contract and the subject loses volitional muscle control of the affected muscles.

The effectiveness of a CEW to cause NMI is not always either 100% or 0%. Depending upon, among other factors, the spread between the probes, location of the probes on the subject's body, clothing, movement, environmental factors, assuming there is a completed circuit, the effective NMI on a CEW deployment varies with the associated factors.

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2. Trilogy Log Download and Analysis:

The Trilogy logs for X2 CEW with serial number X29003K6D were downloaded on October 10, 2018. The Event Log, Engineering Log, and Pulse Logs were used for the analysis in this report.

Clock Drift: Note, due to internal component tolerances and environmental conditions, the internal clock of the X2 CEW can drift up to ± 2 minutes per month. The enclosed Event Log, *TASER_X2_X29003K6D_online.pdf*, indicates that prior to September 11, 2018, the last time synchronization was conducted on the date of manufacture, April 7, 2015 (Line 58). Because the clock was running without synchronization for over 41 months prior to the incident in question, the potential clock drift on September 11, 2018 could be up to ± 82 minutes.

The X2 CEW's clock was synchronized the day after the incident, on September 12, 2018 (Line 2189). At the time of the synchronization, the clock was recorded as running 23 minutes and 20 seconds fast (ahead).

The X2 CEW clock has shown in tests to generally have a consistent clock drift, except when subjected to temperature extremes of -20 degrees Celsius (°C) or 50 °C (-4 degrees Fahrenheit (°F) or 122 °F). The average clock drift calculated from the clock synchronization on April 7, 2015 to the synchronization on September 12, 2018 is 1.12 seconds per day (00:23:20 divided by 1,254 days). If the clock drift remained linear between the synchronizations, it is estimated that the clock drift on September 11, 2018 was approximately 23 minutes and 19 seconds (1.12 seconds time 1 day, rounded down to 1 second, and subtracted from 00:23:20). By subtracting 00:23:19 to the entries on September 11, 2018, the most accurate time of the events can be calculated, assuming that the clock drift remained linear.

3. Event Log Analysis:

The X2 CEW records event information in the Event Log, recording the timestamp, type of event, cartridge information, event duration, CEW internal temperature, and battery capacity remaining. The event duration is rounded up to the nearest second after 0.499 seconds (i.e- an event duration of 1.45 seconds will show as 1 second, but an event duration of 1.50 seconds will show as 2 seconds).

The enclosed Event Log indicates that the X2 CEW with serial number X29003K6D was activated once via the trigger switch and three (3) times via the arc switch on September 11, 2018 between 16:13 and 16:14 EDT, not considering clock drift. The Event Log's entries from the incident on September 11, 2018 are shown in Table 3.1 below, not including potential clock drift at the time of the incident. Table 3.2 below shows the Event Log entries with the logged time and the clock drift corrected time

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(logged time - 00:23:19 of clock drift), both reference in EDT.

Table 3.1- Event Log Details

Seq#	Local Time [EDT]	Duration [seconds]	Detail
2173	9/11/2018 16:13:29	N/A	Armed, Bay 1 (left side from aim perspective) contains 25' cartridge, Bay 2 (right side from aim perspective) contains 25' cartridge.
2174	9/11/2018 16:13:35	6	Safe. The X2 CEW was in Armed Mode for 6 seconds total before the safety switch was engaged.
2175	9/11/2018 16:13:36	N/A	Armed, Bay 1 contains 25' cartridge, Bay 2 contains 25' cartridge.
2176	9/11/2018 16:13:37	9	Trigger, Bay 1 cartridge deployed, Bay 1 activated.
2177	9/11/2018 16:13:41	6	Arc, both bays activated via the arc switch. Only Bay 1 cartridge is deployed
2178	9/11/2018 16:13:49	4	Arc, both bays activated via the arc switch. Only Bay 1 cartridge is deployed
2179	9/11/2018 16:14:02	4	Arc, both bays activated via the arc switch. Only Bay 1 cartridge is deployed
2180	9/11/2018 16:14:13	37	Safe. The X2 CEW was in Armed Mode for 37 seconds total before the safety switch was engaged.

Table 3.2- Clock Drift Correction

Seq #	Recorded Time [EDT]	Clock Drift Correction [EDT]
2173	9/11/2018 16:13:29	9/11/2018 15:50:10
2174	9/11/2018 16:13:35	9/11/2018 15:50:16
2175	9/11/2018 16:13:36	9/11/2018 15:50:17
2176	9/11/2018 16:13:37	9/11/2018 15:50:18
2177	9/11/2018 16:13:41	9/11/2018 15:50:22
2178	9/11/2018 16:13:49	9/11/2018 15:50:30
2179	9/11/2018 16:14:02	9/11/2018 15:50:43
2180	9/11/2018 16:14:13	9/11/2018 15:50:54

4. Pulse Log Analysis:

The Pulse Graphs available on Evidence.com are created from the Pulse Logs in the CEW, which contain electrical information about every pulse that the CEW discharges. Durations in the Event Log are rounded up to the second, while the durations in the Pulse Graphs are accurate to $1/10^{th}$ (or 0.1) of a second.

The X2 records information in the Pulse Logs, which includes the (1) arc voltage, (2) stimulation (stim) voltage, and (3) output charge for each active bay.

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- The arc voltage is the voltage across the arc capacitors in the X2's high voltage module. This voltage gives indication of what level the capacitors needed to be in order to produce an electrical arc.
- The stim voltage is the voltage across the stimulation capacitor in the X2's high voltage module. The stim voltage indicates the voltage that the stimulation capacitor charged up to when an electrical pulse was generated.
- The output charge is the value of the charge (electrical current over time) measured in microcoulombs (µC). One (1) Coulomb is equal to one (1) ampere over one (1) second, so one (1) microcoulomb is equal to 0.000001 amperes per second.

The Arc and Stim voltages give an indication of the load impedance (high or low) and whether the load was stable or not.

High Impedance Load: The load impedance can be high when the cartridge probes partially connect and arc through skin, drive-stun applications, or with probes contacting a subject with high adipose fat tissue content.

Low Impedance Load: The load impedance can be low when arcing across the front of the cartridge or cartridge bay, arcing in water, shorted across metal, or with probes contacting a subject with low adipose fat tissue content.

The output charge indicates whether the capacitors discharged. Based on the extreme variation of loads that the X2 output can arc across, the pulse graphs alone cannot determine the exact situation of a CEW discharge, but rather can be combined with other incident-specific information/reports to imply the type of load, if any, the X2 CEW discharged into. The only definite indications the output charge can provide is when no charge is delivered (0 microcoulombs) or if the charge is within specification when the charge is delivered.

The effectiveness of a CEW to achieve NMI is dependent on not only the output charge in a completed circuit, but also in the location of both probes on the body, and having sufficient probe spread and muscle mass between the probes. The Pulse Graph can indicate when there was potential for an effective discharge and cannot give indication if NMI was achieved.

The times displayed in the Pulse Graphs are referenced to Eastern Standard Time (EST) with Daylight Savings considered. Daylight Savings was in effect in Georgia on September 11, 2018, so the times are shown in reference to EDT.

Based on the above Event Log information and the Pulse Graph information, details of each of the CEW activations on September 11, 2018, and the associated Pulse Graph are below (the times listed do not include clock drift compensation):

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Activation Sequence #2176

The X2 CEW was armed at 16:13:29 EDT, as indicated on Line 2173 and then placed in Safe mode six (6) seconds later at 16:13:35, as indicated on Line 2174. One (1) second later, the X2 CEW was armed at 16:13:36 EDT, as indicated on Line 2175. One (1) second later, Bay 1 was activated via the trigger switch, deploying the cartridge in Bay 1 at 16:13:37 EDT, as indicated on Line 2176. The graph below indicates Bay 1 was active for 9 seconds. A trigger activation will initiate a 5 second cycle, however in this case, the Arc button was pressed 3.5 seconds into the activation and held for 5.5 seconds, making Bay 1 active for a total of 9 seconds. Bay 1 had an average output of only 2.6 µC charge, 867 V on the Arc Capacitor, and 2,993 V on the Stimulation capacitor. The graph indicates the X2 CEW did not have an electrical connection and could not discharge. There was no connection for the entire activation, so there would have been no effect on the subject.

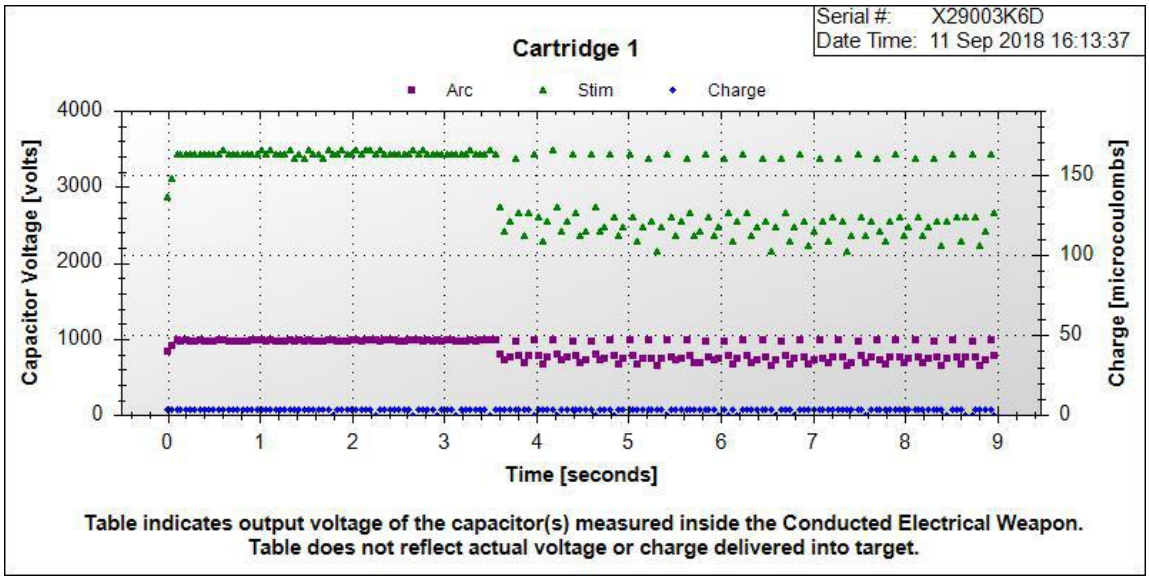

Table indicates output voltage of the capacitor(s) measured inside the Conducted Electrical Weapon. Table does not reflect actual voltage or charge delivered into target.

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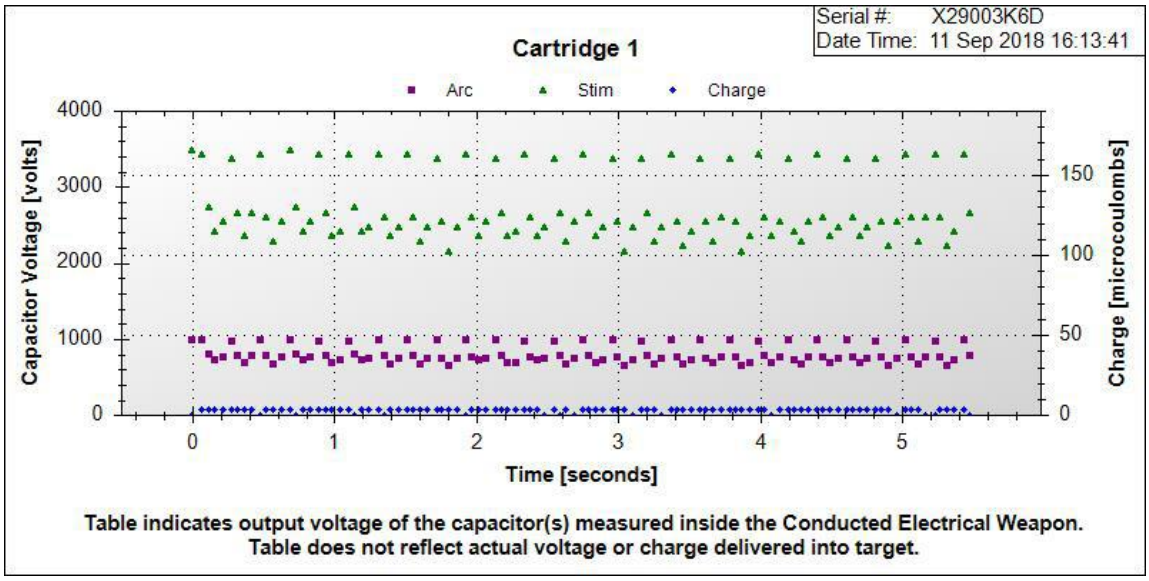
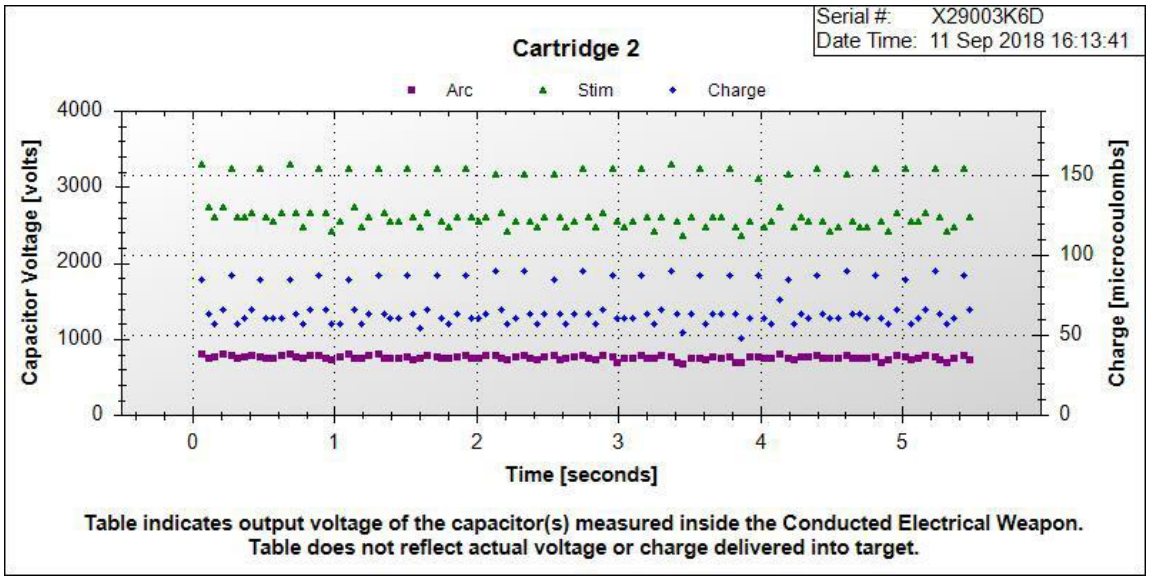
Activation Sequence #2177

3.5 seconds into Activation Sequence 2176, while Bay 1 was still active from its trigger activation, Bay 1 and Bay 2 were activated via the Arc switch at 16:13:41 EDT, as indicated on Line 2177. The graphs below indicate Bay 1 and Bay 2 were active for 5.5 seconds, although Bay 1 was already active for 3.5 seconds when the arc activation began. Bay 1 had an average output of only 2.5 µC charge, 797 V on the Arc Capacitor, and 2,718 V on the Stimulation capacitor. Bay 2 had an average output of 67.5 µC charge, 748 V on the Arc Capacitor, and 2,727 V on the Stimulation capacitor. The graphs indicate Bay 1 had no electrical connection and could not discharge. Bay 2 discharged into a low impedance load, typical of arcing across the cartridge blast doors. The activation had no potential for effectiveness on the subject.





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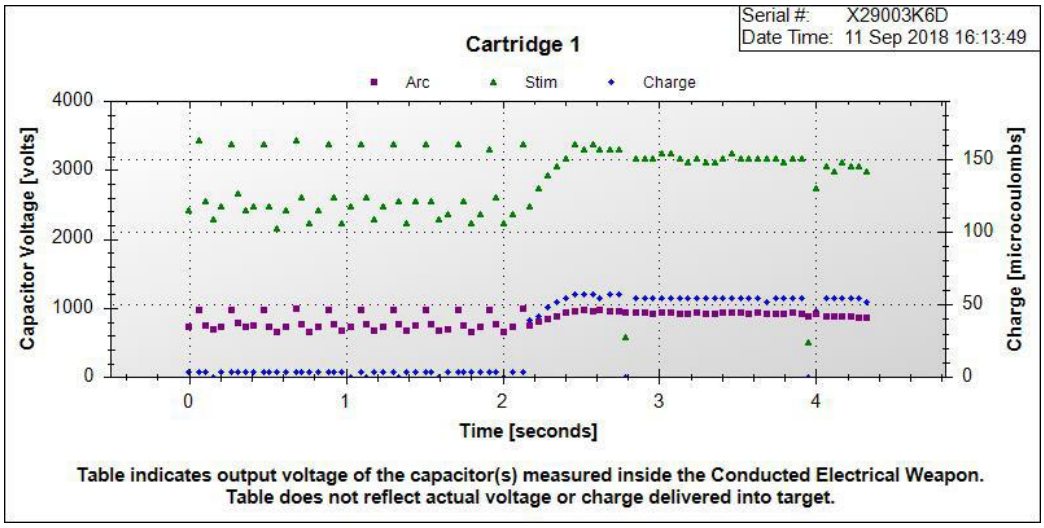
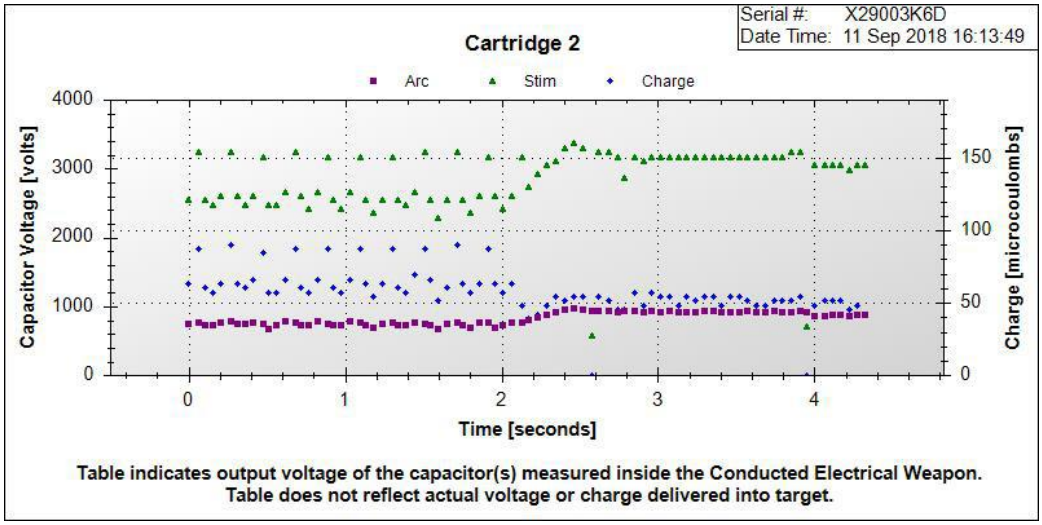
Activation Sequence #2178

Two (2) second after sequence 2177 ended, Bay 1 and Bay 2 were activated via the Arc switch at 16:13:49 EDT, as indicated on Line 2178. The graphs below indicate Bay 1 and Bay 2 were active for 4.4 seconds. For the first 2 seconds, Bay 1 had an average output of only 2.6 µC charge, 782 V on the Arc Capacitor, and 2,668 V on the Stimulation capacitor. After 2 seconds, Bay 1 had an average output of only 50.4 µC charge, 906 V on the Arc Capacitor, and 2,994 V on the Stimulation capacitor. After the initial 2 seconds, Bay 2 had an average output of 48.4 µC charge, 895 V on the Arc Capacitor, and 2,990 V on the Stimulation capacitor. The graphs indicate Bay 1 had no electrical connection and could not discharge for 2 seconds, then discharged into a high impedance load, typical of a drive stun application over skin and possible clothing. Bay 2 discharged into a low impedance load for the first 2 seconds, typical of arcing across the cartridge blast doors, then discharged into a high impedance load, typical of a drive stun application over skin and possible clothing.





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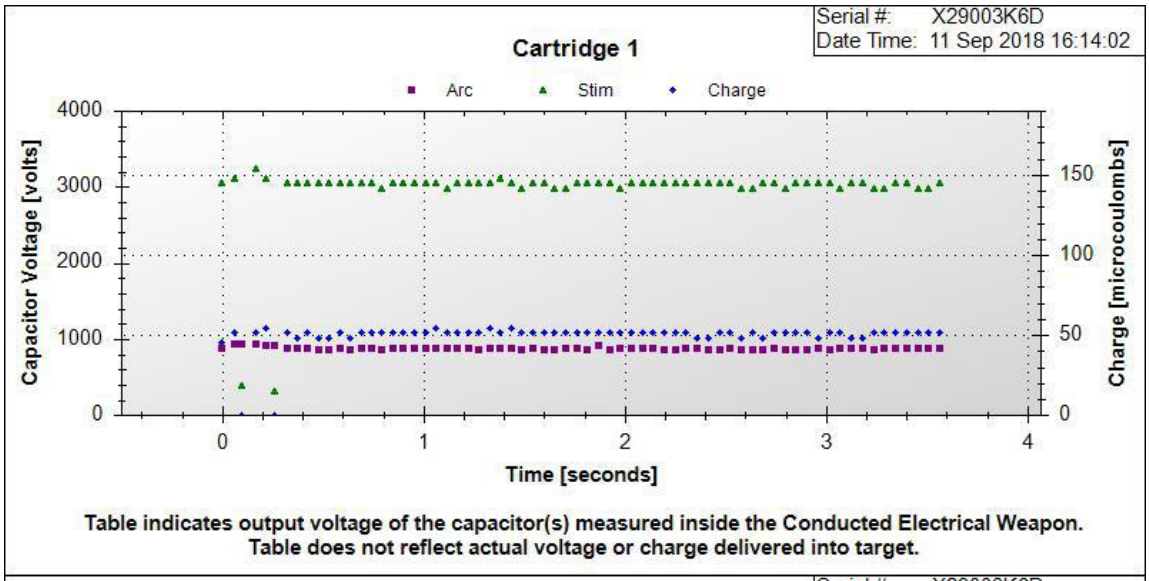
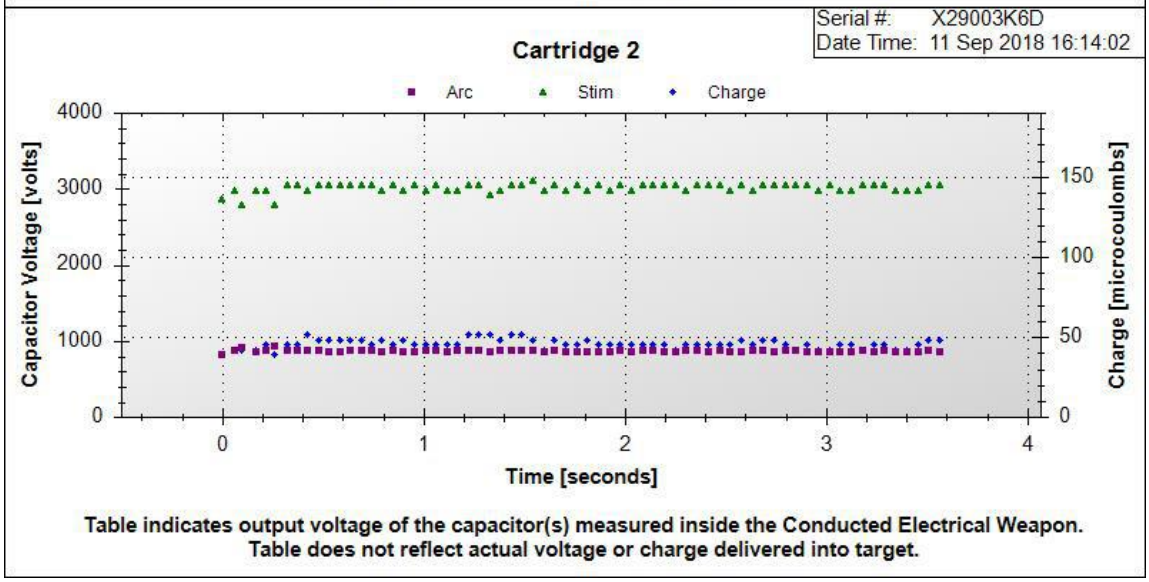
Activation Sequence #2179

Nine (9) second after sequence 2178 ended, Bay 1 and Bay 2 were activated via the Arc switch at 16:14:02 EDT, as indicated on Line 2179. The graphs below indicate Bay 1 and Bay 2 were active for 3.6 seconds. Bay 1 had an average output of 49.1 µC charge, 881 V on the Arc Capacitor, and 2,959 V on the Stimulation capacitor. Bay 2 had an average output of 45.5 µC charge, 875 V on the Arc Capacitor, and 3,013 V on the Stimulation capacitor. The graphs indicate both bays discharged into a high impedance load, typical of a drive stun application over skin and possible clothing. The X2 CEW was placed in Safe mode at 16:14:13 EDT, as indicated on Line 2180.





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5. **Engineering Log Analysis:**

The Engineering Log records specific details about events, states of the CEW, and any faults or errors. The Engineering Log of the X2 CEW with serial number X29003K6D was downloaded and analyzed. Aside from recording when there was no charge delivered (missed pulses), no errors or faults were recorded that would be expected to affect functionality of the CEW.

Summary:

The X2 CEW with serial number X29003K6D was recording data properly in the Trilogy Logs on September 11, 2018. The X2 CEW recorded that it was activated once via the trigger switch and three (3) times via the arc switch on September 11, 2018 between 16:13 and 16:14 EDT (not including clock drift).

Due to natural drift of the X2 CEW's clock, the activation records from September 11, 2018 are subject to 23 minutes and 19 seconds (00:23:19) of positive clock drift. By subtracting 00:23:19 from the entries on September 11, 2018, the most accurate time of the events can be calculated.

The first trigger and arc activation did not have a connection with the subject and would have had no effect. The remaining arc activations appear consistent with a drive stun application over skin and possibly clothing.

TASER recommends that all CEWs be downloaded and clocks synchronized at least every 3 months and that functional tests be performed daily before each shift.

Sincerely,

Bryan Chiles
Technical Compliance Manager
bchiles@axon.com

Enclosures:

- Media containing the Log, specified incident pulse graph, engineering log, and pulse data from X2 CEW with serial number X29003K6D.